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Of Ageing Of Moscow Population And Their Biosocial Meaning: A Pilot Study

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A B S T R A C T

The aim of the present paper is to study sex and gender differences in the biological age and tempos of ageing in men and women of Moscow population. The study is based on the integrated medical-anthropological survey of 69 males from 41 to 92 years of age and 157 females from 41 to 97 years of age, inhabitants of Moscow, examined in 2012. The program included the following: anthropometric measurements (height and weight, waist and hip circumferences); the whole-body impedance was measured on the right hand side of the body using the bioimpedance meter ABC-01 'Medas' (SRC Medas, Russia); functional characteristics of cardiovascular systems: systolic and diastolic blood pressure (mmHg), heart rate (beats per min); hand grip strength for right and left hands measured with the hand dynamometer; estimation of biological age was performed with the software »Diagnostics of Aging. BioAge«, which was developed by the National Centre of Gerontology (Moscow) and included the set of functional biomarkers of cardiovascular and respiratory systems; questionnaire: type of work (mental or physical labour), number of children per family, age at the birth of the first child, father's and mother's longevity. According to the results of this study, in Moscow males there was a tendency to higher intensity of ageing processes as compared to Moscow females. Tempos of age changes in several morphofunctional characteristics (systolic blood pressure, hearing acuity and hand grip strength) were different for both sexes and higher in males. In men there was a higher frequency of individuals with accelerated tempos of ageing (20% vs 12% in women). Higher tempos of ageing in men were much more expressed after 60 years of age, which could be explained by different gender roles and the influence of socioeconomic factors. Among socioeconomic factors, the most important were the following ones: type of work and number of children per family. Slow tempos of ageing were more typical for men and women, who most of their life were involved in mental labour and had only one child.

Key words: *biological age, tempos of ageing, gender differences.*

Introduction

The problem of sex and gender differences in tempos of ageing still remains of considerable interest in modern society. It is well-known that women live longer than men. This is demonstrated by demographic data in many countries. Thus, in Japan men live in average until the age of 78.7 years, and women – until 85.6; in France the corresponding figures are 77.7 and 84.3; in the US – 75.2 and 81 years[1]. In Russia according to statistical data for 2013, average life span for men was 59.1 years and for women 73 years[1].

As for tempos of ageing (rates of development of involutive changes), many authors stated that the process of ageing in women went faster than in men, which could be connected with the end of reproductive function and the beginning of the menopause. In men this process was much slower and more prolonged[2]. According to J.C.Regan and L.Partridge[3], the most important role in sex differences of ageing belonged to steroid hormones which affected the whole body. However in modern post-industrial societies, social factors became more and more significant in their influence on quality of life and its length.

The concept of »biological age« as compared to the chronological (calendar) one, is very useful in the study of individual variations in tempos of ageing. Biological age (BA) is a fundamental characteristic of tempos of ageing. It is an indicator of development, wear and loss of structures and functions of some systems or the organism as a whole. It is determined by a set of metabolic, structural,

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functional, regulatory, and adaptive properties of the organism. As a model concept, it consists of a certain compliancy between the individual level of morphofunctional status and a certain average level for a given age period in a given population[4,5]. Advanced biological age, which surpasses a calendar or chronological one, may be an evidence of functional disorders, degradation of life functions, narrow adaptation range.

Today, about two dozens methods are known for the evaluation of biological age, using different indicators regularly changing with age[6-8]. Among the most recent, convenient, simple, low-cost, and quick techniques are the H-Scan testing method[9] and the package »Diagnostics of Aging: BioAge« (National Gerontological Center, Moscow, Russia, http://www.ngcrussia.org/)[10].

The aim of the present paper is to study sex (biological) and gender (social) factors influencing tempos of ageing in Moscow men and women. Sex differences in ageing processes were considered as totally biological predictors, while gender differences of ageing were determined by social sex roles of individuals in the society.

Materials and Methods

This study was based on the integrated medical-anthropological survey of Moscow citizens conducted in 2012. 69 men from 41 to 92 years of age and 157 from 41 to 97 years were examined.

The program included:

– Anthropometry: height and weight, waist and hip circumferences were taken. Standing height was measured using a Model 101 – Anthropometer (GPM manufacturers, Switzerland, http://www.seritex.com/gpm) and weight was measured on a digital scale. Both circumferences were measured using a measuring tape. Body mass index (BMI) was calculated as body mass (BM) divided by standing height (Ht) squared; waist/hip ratio was calculated as waist circumference divided by hip circumference (this index is a characteristic of sexual dimorphism and it is often called as an index of andro/gynecomorphism);

– The whole-body impedance was measured on the right hand side of the body using the bioimpedance meter ABC-01 'Medas' (SRC Medas, Russia) according to a conventional tetrapolar scheme at a frequency of 50 kHz. Body composition variables, such as fat-free mass, fat mass, skeletal-muscle mass, active cell mass, were determined using appropriate equations provided by the manufacturer[11]; specific metabolic rate was evaluated by the same meter.

– Functional characteristics of cardiovascular systems were measured: systolic and diastolic blood pressure (mmHg) and heart rate (beats per minute).

– Functional characteristics of respiratory system: forced vital lung capacity (FVC, l) and forced expiratory volume in 1 sec (FEV, l) were measured with a portable lung-tester Micro-1.

– Hand grip strength for right and left hands was measured with the dynamometer – DK 50.

The subjects were asked the following questions: their place of birth, time of their coming to Moscow (if they were not born there), type of their labour activity (physical or mental work); number of children they had; age at birth of the first child (for women); their father's and mother's longevity.

The survey took place in the so-called Councils of War and Labour Veterans in the Central Administrative District of Moscow City. All of the visitors of those councils were approached for their consent to be enrolled in the medical-anthropological survey (free of charge) with the purpose of assessing of their biological age and tempos of ageing. Thus, all of the subjects should be regarded as socially active part of the population of Moscow central area. As the numbers of those studied show, women's social activity was almost twice as much as men's (157 vs 69 individuals). Most of the subjects graduated from different universities, and for the larger part of their working career were involved in mental labour (doctors, teachers, accountants, engineers, workers in human services etc.). Both males and females had a number of similar characteristics, which allowed to compare tempos of ageing in two sex groups:

– mean values of the chronological age (56.6 years in males and 59.9 years in females; the differences not statistically significant);

– birth place and place of residence during the lifetime (more than 70% of studied males and females were born in Moscow and lived there throughout their whole lifetime; about 30% of the studied individuals came to Moscow from other Russian cities more than 40 years ago).

– Social status of the investigated individuals was also similar: active social way of living; similar type of labour activity (72% of women and 73% of men were involved in mental labour during all their life; 28% of women and 14% of men were involved in physical labour; 13% of males were in the military service).

At present a lot of different methods for evaluation of biological age have been developed. However in the literature dealing with ageing and senescence problems, there were very few papers where results of different methods of biological age evaluation for the same population, or of the same methods for different populations were compared[12]. In Russia the most popular method of biological age evaluation was developed at Kiev Institute of Gerontology, which then belonged to the USSR Academy of Medical Sciences[13]. It included the set of functional biomarkers of cardiovascular and respiratory systems: systolic and diastolic blood pressure (Hg mm), forced vital lung capacity (l), expiratory breath-holding (sec); crystalline accommodation (the distance of the nearest viewpoint in diopters), acuity of hearing or auditory threshold under 4,000 Hz (dB), body mass (kg), self-evaluation of health status (the number of negative answers to 29 standard questions), Wechsler Adult Intelligence Test (the number of correctly filled cells per 90 sec) and others[14]. This ap-

proach was known as the Kiev method (in 1993 the Institute of Gerontology became part of the Ukraine National Academy of Medical Sciences). This method presented a typical linear regression model, which defined the biological age of men and women according to some equations based on the above-listed traits.

In our study a modern computerized version of the »Kiev« method was used. It was further developed by the National Gerontology Center (Moscow) using some specific equations and taking into account non-linear character of age dynamics in some biomarkers. It was called »Diagnostics of Aging. BioAge«[8,10,15,16]. Among foreign similar products, it can be compared with a computerized research complex H-SCAN 820 Hoch Company USA[9].

The BA estimated for each individual was compared with the chronological age (CA) according to the following procedure:

If BA = CA ± 4 years – an individual was characterized by the average, for this population, tempos of aging;

If BA < CA – 4 years – an individual was characterized by slow tempos of aging;

If BA > CA + 4 years – an individual was characterized by accelerated tempos of aging.

The range of »±4 years« corresponded with the variation range of ± 0.67 SD from the mean value[17].

Statistical analysis was performed with the Statistica (v. 6.0) software (Statsoft Inc., Tulsa, USA). Student's t-test was used for comparison of means in the two subsamples. To compare the means of morphological and functional parameters in the groups with different tempos of ageing, one-way analysis of variance (ANOVA) was used. To find out if there were some correlations between functional traits and BA values (two quantitative traits with continuous variation) rectilinear regression analysis was used.

Research was carried out in compliance with the Helsinki Declaration and approved by Bioethical Committee of Biological Faculty of Lomonosov Moscow State University.

Results

In Table 1 mean values of some parameters of cardiovascular, respiratory and skeletal-muscular systems for the studied men and women are presented. (Table 1)

Comparison between mean values of systolic and diastolic blood pressure, as well as heart rate did not show any differences between the studied men and women. The differences in functional characteristics of external respiration (FVC, FEV1) and hand grip strength might be probably connected with manifestations of biological sexual dimorphism in the above traits: men had bigger total body dimensions, their chest was larger and bigger in volume, strength capacities were also greater in men than in women.

Figures 1-5 show the results of regression analysis in age changes of some characteristics of different systems: cardiovascular (systolic blood pressure), respiratory (FVC), skeletal-muscular (hand grip strength), waist to hip ratio and hearing acuity. As can be seen, there were

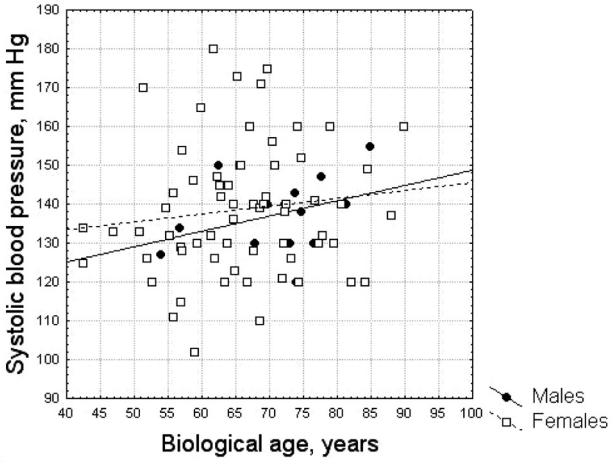

Fig. 1. Age changes of systolic blood pressure in men and women.

TABLE 1
MEANS AND STANDARD DEVIATIONS OF SOME FUNCTIONAL CHARACTERISTICS OF CARDIOVASCULAR, RESPIRATORY AND SKELETAL-MUSCULAR SYSTEMS IN THE STUDIED MEN AND WOMEN

Traits	Women (N=157)		Men (N=69)	
	Mean	Std. Dev.	Mean	Std. Dev.
Systolic blood pressure (Hg mm)	138.8	16.5	136.8	9.6
Diastolic blood pressure (Hg mm)	84.2	10.0	82.5	8.5
Heart rate (beats/min)	74.9	10.8	76.3	14.4
Forced vital lung capacity (FVC, l)*	2.78	0.77	4.20	0.98
Forced expiratory volume in 1 sec (FEV1, l)*	2.29	0.67	3.30	0.85
Hand grip strength (kg)*	20.5	6.1	31.2	8.3
Specific metabolic rate (ccal/m^2)*	835	109.0	942	127.9
Waist /hip ratio	0.88	0.06	0.97	0.04

*statistically significant ($p<0.05$)

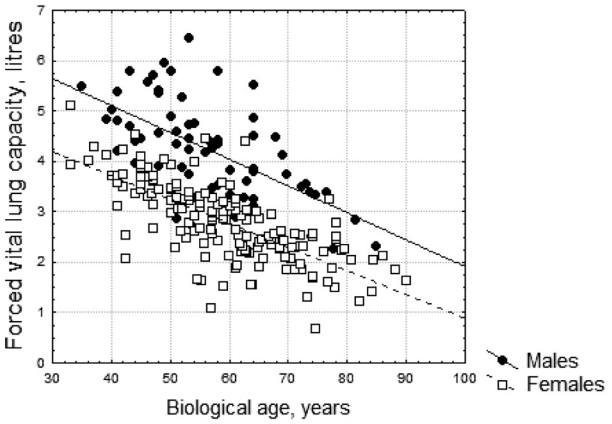

Fig. 2. Age changes of forced vital lung capacity in men and women.

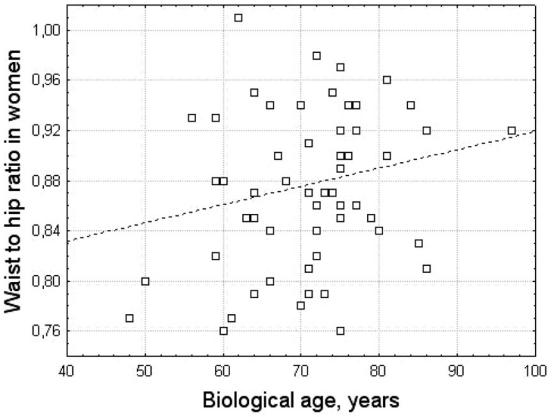

Fig. 4. Age changes of waist to hip ratio in women.

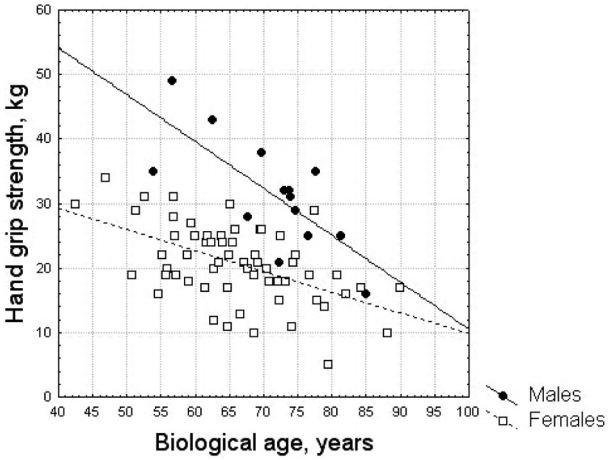

Fig. 3. Age changes of hand grip strength in men and women.

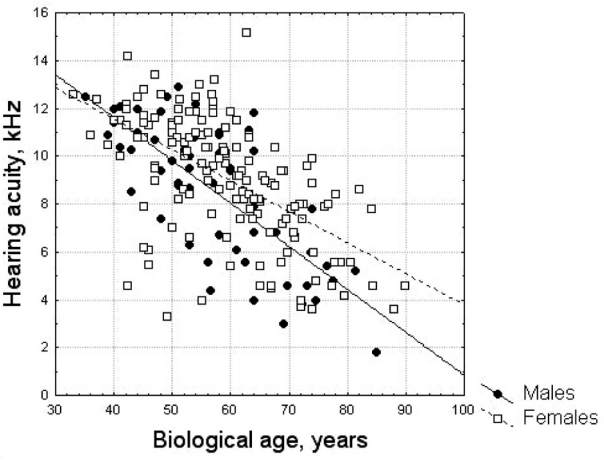

Fig. 5. Age changes of hearing acuity in men and women.

distinct differences in the rate of ageing processes between men and women.(Figure 1, Figure 2, Figure 3, Figure 4, Figure 5)

Absence (Figure2) or presence (Figs. 1, 3 and 5) of sex differences in regression lines of age changes for several morphofunctional characteristics of ageing were demonstrated. Thus, parallel position ($t<1.96$) of regression lines was shown for age changes in forced vital lung capacity, which meant that tempos of ageing were similar for men and women but mean values of this parameter were significantly greater in men at any age.

Figures 1, 3 and 5 demonstrated non-parallel positions of the regression lines for such biomarkers as systolic blood pressure, hand grip strength and hearing acuity. It meant that there were differences in tempos of ageing in those parameters (for hand grip strength it was statistically significant – $p<0.05$).

After evaluation of individual biological age, all the subjects were divided into three groups according to their tempos of aging: with slow, average or accelerated tempos of involutive changes (Figure 6).

In Table 2 the percentage of men and women with different tempos of ageing is given for the two groups of Moscow citizens: for those who were born in Moscow and always lived there (so-called »aboriginals«) and for those who were born in other parts of Russia and came to Moscow over 30 years ago (so-called »migrants«). (Table 2)

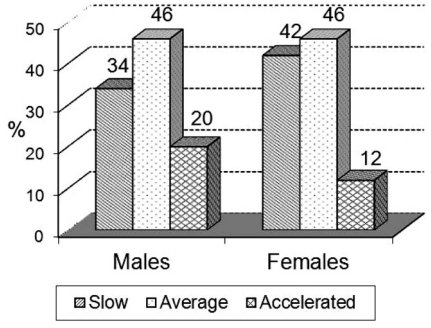

Fig. 6. Percentage of men and women with different tempos of ageing in Moscow population.

TABLE 2
PERCENTAGE OF MEN AND WOMEN WITH DIFFERENT TEMPOS OF AGEING DEPENDING ON THE LENGTH OF THEIR LIVING IN MOSCOW

Length of living in Moscow	Women			Men		
	Tempos of ageing			Tempos of ageing		
	Slow	Average	Accelerated	Slow	Average	Accelerated
»Aboriginals«	61%	37%	2%	40%	50%	10%
»Migrants«	31%	63%	6%	67%	17%	16%

TABLE 3
SOME BIOSOCIAL CHARACTERISTICS IN GROUPS OF MOSCOW MEN AND WOMEN WITH DIFFERENT TEMPOS OF AGEING

Characteristic	Women		Men	
	Slow tempos of ageing	Average tempos of ageing	Slow tempos of ageing	Average tempos of ageing
Type of work:	80%	67%	75%	71%
– mental	20%	33%	25%	29%
– physical				
Number of children	1	1-2	1	2
Age at birth of the first child* (years)	27.2	25.1	-	-
Father's longevity (years)	68.5	66.7	-	-
Mother's longevity (years)	79.1	78.6	81.5	81.6

*statistically significant ($p<0.05$)

In Table 3 the results of questionnaires concerning some biosocial characteristics are given for men and women with different tempos of ageing. (Table 3)

Discussion

Comparison of mean values of cardiovascular characteristics did not show any differences between men and women (see Table 1). There was a strong tendency in both sexes to increase blood pressure with age due to the loss of the elasticity of vessels and increasing resistance to the blood flow in small arteries [2]. However, a more detailed view revealed that sex differences did exist. This was mainly connected with rennin-angiotensin-aldosterone system, which was responsible for the blood pressure and kidneys functioning. Women in premenopausal period had better indicators of cardiovascular system, due to estradiol[18]. Estrogens increased the angiotensin concentration and decreased the level of rennin; testosterone had an opposite effect[19]. This explained lower values of blood pressure in women, compared to men, prior to climacteric age. However, after the menopause the values of arterial blood pressure in women increased and became identical to the males' ones[20]. This could also explain earlier appearance of hypertension in males[21].

Because most of the studied Moscow women were in climacteric age (perimenopausal or postmenopausal), our results did not show any significant sex differences in mean values of cardiovascular characteristics (see Table 1). At the same time, the regression analysis of age changes of systolic blood pressure showed a trend towards higher increase of these characteristics with age in men comparative to women (see Figure 1).

Sex differences in mean values of respiratory characteristics (FVC, FEV1) and hand grip strength, as was already said, could be connected with greater total body sizes in males, their large and voluminous chest, and higher strength capacities. All these traits can be considered as biological manifestations of sexual dimorphism.

Comparisons between the rate of age changes in respiratory characteristics of men and women did not show significant differences. For both sexes the ageing of respiratory system was very similar (see Figure 2).

According to the literature[22–24], after the age of 60 years, chest muscles weaken, costal cartilages lose their elasticity. Significant changes also occur in cells and tissues. All these changes lead to the decrease in forced vital lung capacity. Between 25 and 35 years of age these values do not change but after that age period they become gradually decreasing. It was shown that the rate of decrease was 5 ml per year, and after the age of 60 it was becoming much faster[25]. Our results about the absence of sex differences in the respiratory system age changes are in accordance with the data by other authors[22]. However a higher frequency of age pathologies were found in men, connected with some unhealthy habits (smoking) and harmful professional conditions[26].

Analysis of age changes in hand grip strength showed that in men the decrease of strength capacities went faster than in women. It may be connected with the differences in age changes of body mass components. The loss of body mass was found in groups of elderly people[27]. But in women such a loss was primarily connected with the decrease in fat mass, while in men the fat-free mass (muscles) also demonstrated significant decrease[28], which could influence the strength capacities of the organism. In one of the latest research[29] a reduced muscular strength, as measured by hand grip strength, was considered a predictor of mortality. In this context, a faster reduction of grip strength in ageing Russian men may be connected with their shorter longevity.

The waist/hip ratio is a somatic manifestation of sexual dimorphism, called an index of andro/gynecomorphism[30]. For women the values between 0.6 and 0.8 are most typical; morphologically it is expressed in a narrow waist and broad hips (»pear«-like body shape). The values over 0.8 indicate an increase in fat accumulation on the trunk (predominantly in abdomen area). This can be interpreted as a trend towards »andromorphism«, when fat distribution changes from a female type (prevalence on hips) to the male one (prevalence on the trunk in abdomen area – »apple«-like shape). For men normal variation range of this parameter is 0.8 – 1.0. In spite of the decrease in body mass in elderly men, the values of waist/hip ratio were kept within normal range. The values of this index for women demonstrated an increase with age (see Figure 4), not different from men's mean values, which showed the »andromorphic« type of body build. This is in agreement with other authors' data[31–33].

Age changes of hearing acuity showed that the tempos of hearing loss were much faster in men (see Figure 5). It was also found by other authors[34]. Men as compared to women of the same age group demonstrate lower auditory perception. Accelerated hearing loss starts in men after 40 years of age, while in women – after 50 years of age. Molecular mechanism of hearing loss is not completely studied but is associated with mitochondrial theory of ageing (mitochondrial metabolites accumulating in the cell and damaging it). For the hearing organs this is expressed in the damage of auditory neuroepithelium[35]. Women, at the same time, are characterized with better antioxidant properties, which slow down the ageing process. It was also shown that in men more often than in women the hearing loss was associated with some other diseases[36].

It is also known that an important role in more intensive hearing loss in men is played by social, not only biological factors. Women, being more socially active, feel more uncomfortable when they experience hearing difficulties. That is why they pay attention to such disorders much early than men and seek for medical help[37,38].

The results of our analysis of different versions of ageing and their frequencies among men and women (see Figure 6) showed that in men the accelerated type of ageing occurred more often than in women (20% vs 12%). It could be connected with higher sensitivity of males to environmental conditions. According to many authors[39,40], males show stronger reaction to stress situations caused by ecological or social upheavals.

Apart from biological factors influencing tempos of ageing, many authors emphasize the role of social factors. It was noticed that the transition to the old age brought a sharp change in social roles[41]. Different types of family life style, social positions of the family members, social roles of men and women in modern society were studied to reveal the key factors favoring women's more successful survival at elder ages[42]. Women's life has a set of typical and unique characteristics such as motherhood, combination of private and social activity, psychological adaptability. If at mature age the most important factor both for men and women is social activity, at elder ages family life becomes a priority. In this situation women in Russia happen to be in a more favorable position: after retirement elderly women stay socially active, taking an important grand mothers' place in the families. Social activity of retired men is strongly reduced, self-assessment drops down, and psychological health parameters also worsen, which is reflected in their tempos of ageing[41].

Analysis of questionnaires revealed that tempos of ageing in modern Moscow population were influenced by social factors. As was mentioned before, all studied individuals were divided into two groups: those who were born in Moscow and spent their whole life there – so called »aboriginals«, and »migrants« – those who were born in other cities of RF and came to Moscow more than 30 years ago. The frequency of different versions of ageing in both groups of men and women (see Table 2) showed that most of the women among »aboriginal« group (61%) were characterized with slow tempos of ageing, while in the »migrant« group their number was twice as less (31%). Women with accelerated tempos of ageing were more numerous in the group of »migrants« (6% vs 2% in the »aboriginal« group). In men the differences were not the same as in women: slow tempos of ageing were higher in the »migrant« group (67%), while in the »aboriginal« group males with average tempos of ageing were more numerous (50% vs 17%) (see Table 2).

These results may be explained by differences in social behavior of men and women who came to the megapolis. Women who migrated to Moscow probably experienced much greater burden of stress and socioeconomic problems than men, which influenced their tempos of ageing. It is also possible that men, who left their families after moving to Moscow, felt themselves more comfortable comparative to women who also parted with their families. Men probably experienced more freedom not only in professional but also in their private lives. It might be that such psychological comfort contributed to slowing down tempos of ageing in »migrant« men.

Type of labor strongly influenced tempos of ageing in Moscow population. Many studies show that mental work has a favorable effect on senior people's health[43–45]. This was confirmed by this research. Most of the studied men and women in Moscow population for the most part of their labor activity were involved in mental work (teachers, economists, engineers, academics etc.). In groups of men

and women with average tempos of ageing, compared to those with slow tempos, slightly more individuals were involved in physical labor (industrial workers) (see Table 3).

Among the factors that might have an influence on tempos of ageing, women's age at the first birth and number of children in the family played an important role. There is a viewpoint that the absence of children has a negative influence on longevity as well as their large number (more than four)[46]. Childbirth at an early age (under 20) has a strong effect on female organism, which can lead to early onset of cardiovascular and respiratory diseases and, as a result, to a shorter life-span[47]. Having their first-born at a later age slows down tempos of ageing in women[48-52]. At the same time, there are some data disproving the above conclusions[53]. In our study men and women with slow tempos of ageing, as a rule, had only one child in the family. Significant differences ($p<0.05$) between two subgroups of women with slow and average tempos of ageing were found for such characteristics as »age at birth of the first child«. Women with slow tempos of ageing had their first born at a later age (27.2 vs 25.1 years correspondingly), which supports the data by other authors [48-52].

It is well-known that the ageing process depends on both genetical and environmental factors[25,54,56-58]. Before the genome era, one of the most widespread sources of the information on genetic causes of ageing and longevity was the study of people's genealogies by questionnaires. We also used this method, though limited to only one question, to study if there were any associations between the life span of family members. The comparison of fathers' and mothers' longevity in the subgroups of people with different tempos of ageing did not show any significant differences. However among women of the slow ageing group, fathers and mothers lived longer than in two other groups.

Conclusion

The results of the study showed sex and gender differences in tempos of ageing in Moscow population. More intensive tempos of ageing were observed in men for systolic blood pressure, hearing acuity and hand grip strength. In Moscow men the accelerated tempos of ageing were much higher than in women.

Among social factors, tempos of ageing were mostly associated with the type of labour activity and number of children in the family: both men and women with slow tempos of ageing were involved in mental labour and had only one child in the family.

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RAZLIKE IZMEĐU SPOLOVA U TEMPU STARENJA U POPULACIJI MOSKVE I NJIHOVO BIOSOCIJALNO ZNAČENJE

S A Ž E T A K

Cilj ovog rada je bio istražiti seksualne i spolne razlike u biološkoj dobi i tempo starenja kod muškaraca i žena u populaciji Moskve. Istraživanje se temelji na integriranom medicinsko-antropološkom istraživanju 69 muškaraca u dobi od 41 do 92 godina i 157 žena u dobi od 41 do 97 godina starosti, stanovnika Moskve koji su ispitani u 2012. Program je uključivao sljedeće: antropometrijska mjerenja (visina i težina, obujam struka i kukova); impedancija cijelog tijela je mjerena na desnoj strani tijela pomoću ABC-01 'Medas' (SRC Medas, Rusija) mjerača bioimpedance; funkcionalne karakteristike kardiovaskularnog sustava: sistolički i dijastolički krvni tlak (mmHg), otkucaji srca (otkucaja u min); snaga rukohvat za desne i lijeve ruke izmjerenih s ručnim dinamometrom; procjena biološke dobi provedena je pomoću softvera »Diagnostics of Aging. BioAge«, koji je razvijen od strane Nacionalnog centra za gerontologiju (Moskva) i uključuje skup funkcionalnih biomarkera kardiovaskularnog i dišnog sustava; Upitnik: vrsta posla (mentalan ili fizički rad), broj djece po obitelji, dob pri rođenju prvog djeteta, oca i dugovječnost majke. Prema rezultatima ovog istraživanja, kod muškaraca iz Moskve postoji tendencija većeg intenziteta starenja u odnosu na žene. Tempo u promjenama dobi u nekoliko morfofunkcionalnih karakteristika (sistolički krvni tlak, oštrina sluha i snaga rukohvata) bile su različite za oba spola i veći kod muškaraca. Kod muškaraca je postojala veća učestalost pojedinaca s ubrzanim tempo starenja (20% u odnosu na 12% kod žena). Viši tempo starenja kod muškaraca je izraženiji nakon 60 godina života, koja bi se mogla objasniti različitim rodnim ulogama i utjecaju socioekonomskih čimbenika. Među socioekonomskim čimbenicima, najvažniji su slijedeći: vrsta posla i broj djece po obitelji. Spor tempo starenja su više tipične za muškarce i žene koji su većinu svog života bili posvećeni mentalnom rada te su imali samo jedno dijete.